This raises the question as to the part played by the nucleus of a cell in its respiratory processes.

Is the source of muscular energy to be sought in oxidation or cleavage processes in tissues? In some animals there is not a direct relation between the muscular work and oxygen consumed, though there is to heat production. Bunge, on this ground, thought that the intestinal parasites of warm-blooded animals must have their oxygen at a minimum. In the intestinal contents there is no estimable oxygen; there active reduction processes go on. Entozoa might get oxygen from O_2 diffusing from blood-vessels.

Bunge found that intestinal worms of the cat and pike can live in an alkaline solution of common salt, free from gases, under Hg, for four to six days. They made active movements, and gave off much CO_2.

Ascaris lumbricoides from the intestine of the pig lived four to six days in 1 per cent. boiled NaCl solution. It made little difference whether oxygen or hydrogen was passed through the fluid. They lived seven to nine days if fluid was saturated with carbon dioxide, so that they have accommodated themselves to high percentages of carbon dioxide.

They give off to the fluid valerianic acid, an acid with a characteristic butyric acid odour. These worms contain a very large quantity of glycogen, the dry body yielding 20 per cent. to 34 per cent. of this carbohydrate.

100 grams Ascaris, placed in boiled normal saline solution, used per day—

0·7 gram glycogen,
0·1 ,, sugar,
No fat;

and yielded—

0·4 gram CO_2
0·3 valerianic acid.

It would seem that glycogen had split into CO_2, and valerianic acid—

$$\begin{array}{ccccccc} 4C_6H_{12}O_6 & = & 9CO_2 & + & 3C_5H_{10}O_2 & + & 9H_2 \\ 720 & = & 396 & + & 306 & + & 18. \end{array}$$

Is it a genuine fermentation?

Weinland found that he could express by Buchner's method a substance, "zymase," which could split glycogen into CO_2 and valerianic acid.

Turning now to respiration in invertebrate animals, and dealing first with those which live in water, let us see some of the contrivances by which this end is achieved. The mechanisms are but means to an end. The ultimate union of oxygen, and the discharge of carbon dioxide with the liberation of energy, occur in the protoplasm of the cell itself.

There are two distinct processes, and it may be that the oxygen is introduced by one portal and the carbon dioxide got rid of by another, or it may be that one portal may do for both processes—the letting in of oxygen and the giving off of carbon dioxide.

Although the principle itself is simple, the variety of mechanisms adopted by nature to secure this double function is remarkable. Let us glance at some of the mechanisms proceeding from the simple to the complex, and first with regard to those animals that live in water.

Consider the oceanic fauna. It is immense both from the point of view of number and variety. Save insects and certain groups of molluscs, all invertebrates are aquatic. Amongst vertebrates, fishes have aquatic respiration, and some mammals, *e.g.* cetaceans or whales, have water as their sphere of existence, though they depend on the air for their respiratory oxygen.

The evolution from an aquatic to an aërial mode of existence can be traced in the animal kingdom, and may even be seen within limits in the history of certain species.

Every living cell, animal or vegetable, requires for its continued existence a supply of oxygen, and every living cell exhales carbon dioxide. The exchange of these two gases between the fluids of the body and the outer medium is the process of respiration. The simplest form of respiratory exchange occurs where there is no specially differentiated organ or mechanism for this purpose, so-called diffuse respiration. The whole surface of the organism in a watery medium may be concerned in this respiratory exchange. This is only possible, however, so long as the boundary surface, skin, or otherwise is permeable to gases, and no great respiratory exchanges are necessary.

Before showing you some lantern slides, I should like to point out how one process is made to aid another.

Motion associated with respiratory processes.

Ciliary motion with respiration and the capture of prey for food.

The old idea of one function for an organ is exploded. One speaks of one man one vote. One man one value. It is not really so.

With Shelley we may say—

"Nothing in this world is single;
All things, by a law Divine,
In each other's being mingle."

As regards the surfaces for these respiratory exchanges for diffuse respiration, it may take place through the inner surface of the body cavity of cœlenterates, the under surface of the bell of a medusa, the tentacles of an echinus, the respiratory tree at the hind gut of the sea cucumber, or the intestine of the young of the dragon fly, or by the intestinal mucous membrane of the mites which have no lungs or other directly respiratory organ. In the higher animals we have tracheæ, gills and lungs.

In some animals, the respiratory mechanism is closely related to the motor apparatus, as in some crustacea. In some mollusca the nutritive and respiratory mechanisms are closely related. In the highest of all there is central apparatus—gills or lungs—for the respiratory exchange between the blood and the air, and a circulatory apparatus for carrying the blood to and from the respiratory organs. The adaptivity of insects to varied conditions of oxygen supply is marvellous.

Before showing some classical experiments and illustrating the principles already laid down, I should like again to direct your attention to the association of several processes with respiratory mechanisms.

[The lecture was illustrated by means of lantern slides, showing the respiratory mechanisms from the lowest to the highest animals, and also by a number of experiments dealing with the chemical exchanges in the process of respiration. Lastly, the classical experiment of John Hunter, on the pneumaticity of the bones of birds, was shown in the duck. A candle flame was extinguished when held in front of the divided trachea, when air was blown into the divided humerus bone of the wing.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

On June 27, Amherst College, Massachusetts, conferred the degree of M.A. upon Mr. Lundin, of Messrs. Alvan Clark and Sons, the following being President Harris's characterisation:—"CARL AXEL ROBERT LUNDIN: Scientific expert in cutting and fashioning glasses of great telescopes. He has done important work on the large objectives of Russia, of the Lick and Yerkes observatories, and lately on the 18-inch objective of the Amherst College Observatory, which is wholly his work. In 1854 Amherst conferred the degree of Master of Arts on Alvan Clark, who had built our first telescope. The same degree, for a similar service, is conferred on his successor, who has kept pace with the progress of astronomical science."

An interesting inquiry as to the representation of science in the principal public libraries of Paris is being made by the *Revue Scientifique,* and the results are published week by week, from July 1 onwards, in the form of letters and opinions from the principal librarians and professors of science in France. The opinion is generally expressed that an unsatisfactory state of affairs exists in libraries such, for instance, as the Bibliothèque nationale and the library of the University of Paris owing to the fact that the librarians are almost exclusively graduates in arts and letters, and ignorant of the requirements of men of science. It thus happens that, the available funds

being limited, preference is given in the purchase of foreign works to the departments of history, letters, and the arts, these being the subjects in which the librarians themselves have special interest and knowledge. Important scientific books are thus often overlooked. The current books of reference and the principal foreign journals are difficult of access, and are not at hand for immediate use; journals are often not available for a year, or more, after the date of issue owing to their being sent to the binders. For these reasons, and on account of the time wasted in waiting and formalities, the principal libraries are hardly used at all for scientific purposes by most of the workers engaged in active research. The professors and teachers of Paris consider that the special libraries attached to the actual laboratories are more valued and are of greater use than the larger and more general libraries, and that these should be coordinated so as to be available for any properly accredited worker. On the other hand, there seems to be a desire on the part of the Government to limit the usefulness of these actual working libraries by reducing the grants formerly allotted to them. Some of the criticisms of the Paris libraries and suggestions for their amelioration are not without application in this country.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 15.—"Contributions to the Physiology of Mammalian Reproduction. Part i., The Œstrous Cycle in the Dog. Part ii., The Ovary as an Organ of Internal Secretion." By F. H. A. **Marshall** and W. A. **Jolly**. Communicated by Prof. E. A. Schäfer, F.R.S.

The experiments lead to the conclusion that the ovary is an organ providing an internal secretion which is elaborated by the follicular epithelial cells or by the interstitial cells of the stroma. This secretion circulating in the blood induces menstruation and heat. After ovulation, which takes place during œstrus, the corpus luteum is formed, and this organ provides a further secretion the function of which is essential for the changes taking place during the attachment and development of the embryo in the first stages of pregnancy.

June 8.—"Researches on Explosives." Part iii. By Sir Andrew **Noble**, Bart., K.C.B., F.R.S.

The principal object of the researches which are communicated in this paper was to ascertain, with as much accuracy as possible, the differences in the transformations which modern explosives suffer when fired under gradually increasing pressures. The first part of the paper gives a description of the varied apparatus employed.

Although the author has made experiments with many other explosives, those examined in this paper are three in number:—(1) Cordite; (2) the cordite known as M.D.; and (3) a tubular nitro-cellulose.

The modes of observation and calculation followed are described, and then in tabular form are given the results of the series of experiments on the three explosives named. These tables being too extensive to reproduce in full, the results of the experiments at the lowest and highest densities alone are given:—

	Cordite Mark I.		M.D. Cordite		Nitro-Cellulose	
Density of charge exploded.	0·05	0·50	0·05	0·45	0·05	0·45
Volumes of permanent gas per gram.	678·0	623·6	781·8	676·3	814·7	680·9
Volume of total gas per gram.	877·8	798·8	955·4	810·6	993·1	816·3
Percentage volumes of permanent gases.						
CO_2 ...	27·15	41·95	18·15	36·60	17·90	35·00
CO ...	34·35	19·10	42·60	24·80	43·45	27·85
H ...	17·50	12·05	23·15	11·90	24·40	12·65
CH_4 ...	0·30	7·05	0·35	10·70	0·60	11·10
N ...	20·70	19·85	15·75	16·00	13·65	13·40
Percentage volumes of total gases.						
CO_2 ...	20·97	33·02	14·85	30·56	14·68	29·16
CO ...	26·53	15·03	34·87	20·71	35·63	23·20
H ..	13·52	9·48	18·95	9·94	20·01	10·54
CH_4 ...	0·23	5·55	0·29	8·94	0·49	9·25
N ...	15·99	15·62	12·89	13·36	11·19	11·16
H_2O ...	22·76	21·30	18·15	16·49	18·00	16·69
Percentage weights of total gases.						
CO_2 ...	36·10	51·84	27·69	48·75	28·19	47·26
CO ...	29·00	15·03	41·38	21·02	43·53	23·92
H ...	1·14	0·67	1·62	0·72	1·74	0·79
CH_4 ...	0·18	3·18	0·18	5·19	0·34	5·45
N ...	17·63	15·65	15·32	13·59	13·71	11·54
H_2O ...	15·95	13·63	13·81	10·73	12·49	11·04
Pressure in tons per square inch.	2·9	52·9	2·7	43·22	3·35	40·5
Pressure in atmospheres.	442·1	8063·8	411·6	6587·3	510·7	6173·6
Units of heat, water fluid.	1272·3	1360·0	1035·9	1190·0	896·1	1036·9
Units of heat, water gaseous.	1186·8	1287·0	961·9	1132·5	829·2	977·7
Specific heat.	0·23040	0·22385	0·23714	0·22529	0·23772	0·22828
Temperatures of explosion, Centigrade.	5151°·1	5749°·4	4056°·2	5026°·8	3488°·1	4282°·9
Comparative potential energy.	0·9825	1·0000	0·8401	0·8842	0·7389	0·7686

If the figures given in these tables be carefully examined, it will be observed that for the three explosives the transformation on firing appears, in all, to follow the same general laws.

Thus in all three there is, with increase of pressure, at first a slight increase, afterwards a steady decrease, in the volume of permanent gases produced.

In all three explosives there is, with increased pressure, a large increase in the volume of carbonic anhydride, and a large decrease in the volume of carbonic monoxide. In the volume of hydrogen this decrease with increase of pressure is very great; while methane, the percentage of which with low pressures is quite insignificant, very rapidly increases, and at the highest density is from twenty to thirty times greater than at the lowest density.

There are some variations in the percentages of nitrogen and water vapour, but on the whole these constituents may be considered to be nearly constant.

The units of heat developed show with increased pressure a slight decline at first, but afterwards increase somewhat rapidly at the higher pressures.

In the tables submitted it will be observed that the specific heats and the temperatures of explosion have been given, but with respect to temperatures so far above those in regard to which accurate observations have been made the figures given can only be taken as provisional.

These temperatures have been obtained by dividing the units of heat (water gaseous) by the specific heats; although provisional, they can safely be used in comparing the temperatures of explosion of the three explosives.

The comparative approximate potential energies are obtained by multiplying the volume of gas produced by the temperature of explosion. The means for the three explosives are respectively:—cordite, 0·9762; M.D., 0·8387; nitro-cellulose, 0·7464. The highest potential energy (taken as unity), it will be noted, was obtained from cordite at a density of 0·5.

It is submitted that the wide differences in the transformation of the three explosives with which the experiments have been made justify the general conclusion at which Sir F. Abel and the writer arrived in the year 1874 (*Transactions of the Royal Society*, vol. clxiii. p. 85) with respect to gunpowder, viz. that any attempt to define by a chemical equation the nature of the metamorphosis which